Short report

Social inequality and the syndemic of chronic disease and COVID-19: county-level analysis in the USA

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Abstract

Background Given the effect of chronic diseases on risk of severe COVID-19 infection, the present pandemic may have a particularly profound impact on socially disadvantaged counties.

Methods Counties in the USA were categorised into five groups by level of social vulnerability, using the Social Vulnerability Index (a widely used measure of social disadvantage) developed by the US Centers for Disease Control and Prevention. The incidence and mortality from COVID-19, and the prevalence of major chronic conditions were calculated relative to the least vulnerable quintile using Poisson regression models.

Results Among 3141 counties, there were 5 010 496 cases and 161 058 deaths from COVID-19 by 10 August 2020. Relative to the least vulnerable quintile, counties in the most vulnerable quintile had twice the rates of COVID-19 cases and deaths (rate ratios 2.11 (95% CI 1.97 to 2.26) and 2.42 (95% CI 2.22 to 2.64), respectively). Similarly, the prevalence of major chronic conditions was 24%–41% higher in the most vulnerable counties. Geographical clustering of counties with high COVID-19 mortality, high chronic disease prevalence and high social vulnerability was found, especially in southern USA.

Conclusion Some counties are experiencing a confluence of epidemics from COVID-19 and chronic diseases in the context of social disadvantage. Such counties are likely to require enhanced public health and social support.

Introduction

In the past, pandemics have disproportionately affected poorer populations, widening existing social inequalities.[1–3] The COVID-19 has now spread throughout the USA, and there is growing evidence of disparities between different socio-economic groups in mortality from COVID-19.[4] Yet the extent of these disparities, and how they might be addressed, requires further characterisation.

Chronic conditions, including chronic obstructive pulmonary disease, heart disease, diabetes and chronic kidney disease, have emerged as important risk factors for severe illness from COVID-19

infection,[5] and there is a particular concern that socially disadvantaged populations might be affected by a confluence of epidemics from chronic diseases and COVID-19, which may exacerbate each other: a concept known as 'syndemics', defined as 'the presence of two or more disease states that adversely interact with each other, negatively affecting the mutual course of each disease trajectory, enhancing vulnerability and which are made more deleterious by experienced inequities.'[6]

Social disadvantage has been variously measured. The US Centers for Disease Control and Prevention (CDC) has previously employed a Social Vulnerability Index (SVI; constructed using census data) to identify counties that are especially vulnerable to the economic and social consequences of a major environmental disaster.[7 8] However, empirical data on its value in identifying areas at particular risk during the current COVID-19 pandemic are scarce.

This study explores the social disparities in the effect of the COVID-19 pandemic between US counties. It aims to quantify the relation between county-level social disadvantage (as measured by SVI) and COVID-19 incidence and mortality. Such findings will inform our understanding of the social determinants of COVID-19, and the utility of measures such as SVI in the public health response to the pandemic. The study also aims to describe the geographical distribution of socially disadvantaged counties that have both high prevalence of chronic diseases and high mortality from COVID-19 (ie, those counties that are experiencing a syndemic of diseases), which are likely to need particular public health and social support over the course of the pandemic.

Methods

County-level social vulnerability was assessed using the SVI developed by the US CDC, with data from the 2018 American Community Survey. Details of the parameters and methods used to construct the index have been described in detail elsewhere.[7 8] In brief, it is a composite measure of 15 socioeconomic and demographic factors reported in the US Census (including the level of poverty, unemployment, crowded housing and health insurance coverage). The index was developed to identify counties that were most vulnerable to the social and economic impacts of major environmental disasters, and as such most likely to require public assistance after such an event; higher SVI score indicates greater social vulnerability.

County-level data on COVID-19 cases and deaths up to 10 August 2020 were obtained from USAFacts, a source of COVID-19 data used by the CDC (https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/previouscases.html). County-level prevalence of five major chronic conditions associated with COVID-19 severity among adults aged ≥18 years were obtained from US CDC, using data from the 2018 Behavioural Risk Factor Surveillance System (BRFSS) and the US Census population.[5] Information was obtained on the prevalence of obesity (body mass index ≥30 kg/m^2), diabetes mellitus (types 1 and 2), chronic obstructive pulmonary disease, heart disease (angina or coronary heart disease and myocardial infarction) and chronic kidney disease.[5]

Statistical analysis

We used Poisson regression, with the log of the population as an offset, to model the association between SVI and COVID-19 cases and deaths. We added a scale parameter to address the issue of potential overdispersion,[9] and used US States as a fixed-effect to adjust for state-level confounding factors.[10] We checked the robustness of these analyses by using negative binomial regression models. The same approach was used to examine the association between SVI and prevalence of the chronic conditions. We also mapped the joint distribution of COVID-19 mortality and each of the five chronic conditions in the most-deprived counties (fourth and fifth quintiles combined). Statistical analysis was performed using Stata statistical software V.14.2 (StataCorp) or Python (V.3.7.7).

Results

After excluding one county due to missing information on SVI, 3141 counties from 50 states of the USA and the District of Columbia were analysed, representing more than 327 million people. Relative to the lowest SVI quintile, counties in the highest quintile had a higher proportion of people in poverty (9.2% vs 23.6%), in unemployment (3.3% vs 8.7%), without health insurance (6.6% vs 14.3%), and from ethnic minority populations (9.7% vs 46.6%), but lower per capita income (US$ 32 000 vs US$ 21 000) (online supplemental table S1).

By 10 August 2020, a total of 5 010 496 cases and 161 058 deaths from COVID-19 had been reported. The rate of COVID-19 cases and deaths increased in a dose-response manner with increasing levels of SVI (table 1). Compared with the lowest SVI quintile, the adjusted rates of COVID-19 cases in the second, third, fourth and fifth quintile were 24% (95% CI 16% to 33%), 39% (95% CI 30% to 49%), 76% (95% CI 65% to 87%) and 111% (95% CI 97% to 126%) higher, respectively, while the rate of COVID-19 deaths was 19% (95% CI 9% to 30%), 22% (95% CI 12% to 33%), 77% (95% CI 63% to 92%) and 142% (95% CI 122% to 164%) higher, respectively. In sensitivity analyses, additionally adjusting for county-level proportions of people ≥65 years did not materially alter the findings. Neither was there any effect of restricting the analyses to counties with at least one COVID-19 case or death, or when using negative binomial regression models as opposed to Poisson regression models (online supplemental table S2).

- VIEW INLINE

- VIEW POPUP

Table 1

COVID-19 cases and deaths in 3141 US counties as of 10 August 2020, by quintiles of Social Vulnerability Index

Higher levels of SVI was also associated with higher prevalence of each of the five chronic conditions (online supplemental table S3). Compared with the lowest quintile, the adjusted prevalence of obesity, diabetes, chronic obstructive pulmonary disease, heart disease and chronic kidney disease in the highest quintile was 24% (95% CI 22% to 26%), 41% (95% CI 39% to 43%), 32% (95% CI 28% to 35%) and 25% (95% CI 22% to 28%) and 32% (95% CI 30% to 35%) higher, respectively.

Maps of the joint distribution of COVID-19 mortality with prevalence of each of the chronic conditions among the most deprived counties (fourth and fifth SVI quintiles together) shows marked geographical clustering of areas with both high COVID-19 mortality and high prevalence of chronic diseases (ie, those counties experiencing a syndemic of diseases), particularly in the southern US states of Mississippi, Georgia, Louisiana and Texas (figure 1). However, there was substantial variation in both COVID-19 mortality and chronic disease prevalence among counties, with many reporting low COVID-19 mortality despite high prevalence of chronic disease and social vulnerability. In analyses that compare the characteristics of counties with high levels of both COVID-19 mortality and chronic diseases (ie, counties experiencing a syndemic of diseases) to those counties with low levels of both COVID-19 mortality and chronic diseases, the proportions of people ≥65 years did not differ between groups, whereas the proportion of people in poverty, unemployed, without health insurance or from an ethnic minority population was substantially higher among counties that experienced the syndemic (online supplemental table S4).

Obesity

Heart Disease

Chronic obstructive pulmonary disease
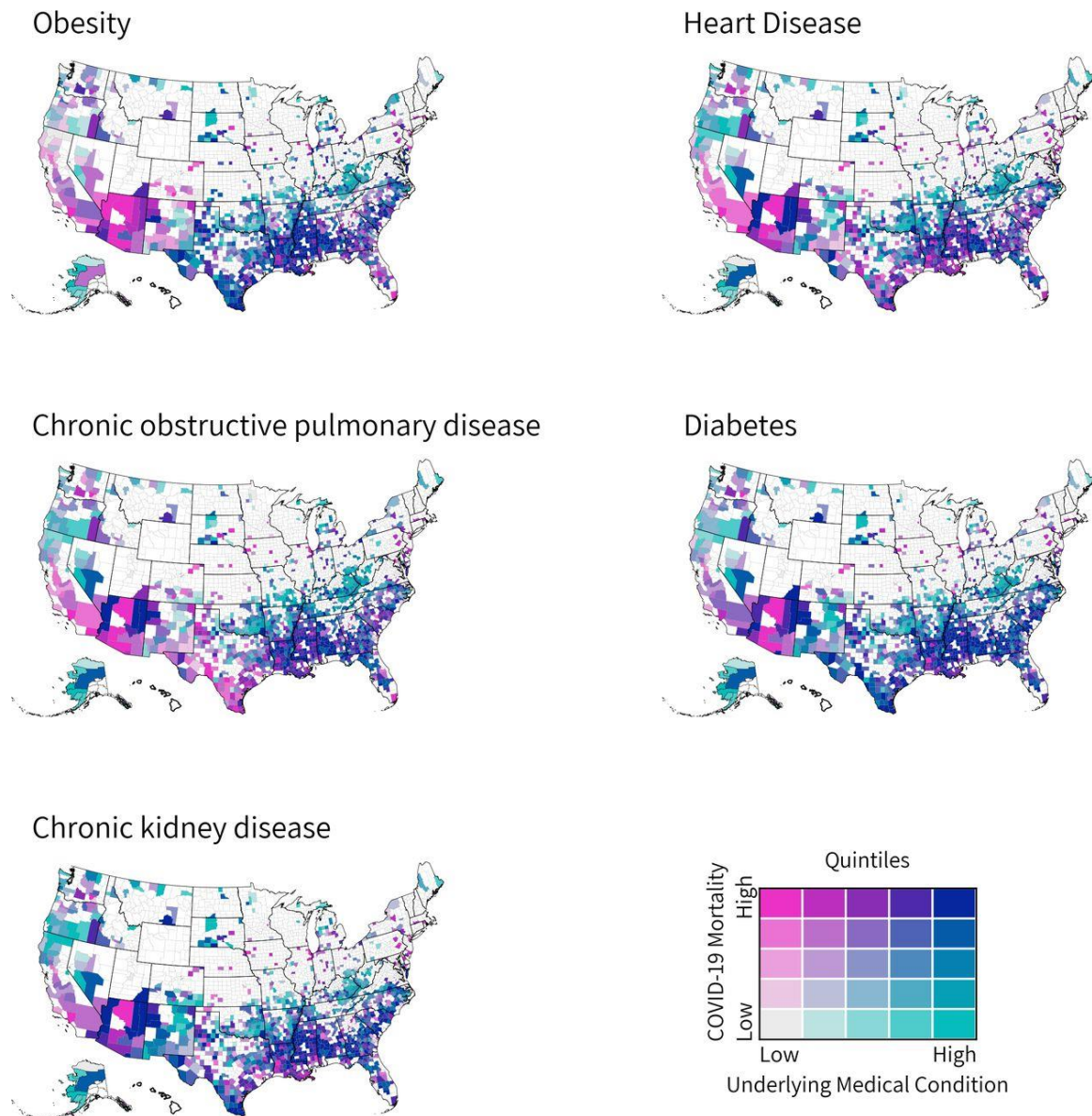

Diabetes

Chronic kidney disease

Figure 1

Geographical distribution of county-level prevalence of major chronic conditions and COVID-19 mortality rates as of 10 August 2020, among the most socially vulnerable counties in the USA. Analyses restricted to counties in the 4th and 5th quintiles of the Social Vulnerability Index of the US Centers for Disease Control and Prevention. Maps give overlapping quintiles of county-level prevalence of major conditions (online supplemental table S3) with COVID-19 mortality rates (table 1) up to 10 August 2020. Data: 2018 Behavioral Risk Factor Surveillance System; COVID-19 deaths from USAFacts.

Discussion

In this study of 3141 US counties, county-level SVI was strongly associated with both cases and deaths from COVID-19, with those in the highest SVI quintile having about double the rate of cases and deaths of those in the lowest quintile. SVI was also associated with the prevalence of each of the five major chronic conditions, and the mapping of counties indicated some areas (especially in the southern USA) are experiencing a confluence of epidemics from chronic diseases and COVID-19 in the context of social vulnerability.

Social disadvantage is strongly related to overcrowded living conditions, reduced likelihood of working conditions that permit physical distancing, and reduced likelihood of seeking and using healthcare services, among other factors that might exacerbate the impact of spread and clinical course of infectious disease epidemics.[11–14] Such populations are also more likely to suffer from

chronic diseases, as found in the present report. Given chronic conditions, including heart disease, obesity, and diabetes, are themselves major risk factors for the severity of COVID-19 infections, and it is becoming clear that the combined effects of social disadvantage itself on the potential for COVID-19 to propagate, together with the cocurrent chronic disease epidemic among these counties, is driving the disproportionate impact of COVID-19 on these populations.[15–17]

The social disruption accompanying the response to the COVID-19 pandemic has in turn adversely affected the management of chronic diseases, as well as the socioeconomic circumstances of the poorest counties, highlighting the complex syndemic nature of COVID-19. The mapping of counties in the present report illustrates that some areas are particularly affected by chronic diseases, social disadvantage, and the COVID-19 pandemic. However, there also some counties with high social vulnerability and high prevalence of chronic disease that have not experienced high rates of COVID-19 deaths, suggesting there may be important lessons from the response to the pandemic in these counties that could be applicable elsewhere.

It is also worth noting that some counties had lower prevalence of chronic conditions despite higher social vulnerability, including parts of Texas and California, which might be attributable to health and social policies in these states.[18 19] For example, California has been at the forefront of implementing a range of policy interventions to address smoking, such as an increase in cigarette tax.[18–20]

Our study has some limitations. First, the reporting of COVID-19 infections and deaths is dependant on testing, and the associations between SVI and rates of COVID-19 cases and deaths may be even stronger if testing is less prevalent in socially vulnerable areas. Second, the prevalence of chronic diseases examined in this study were obtained from BRFSS in 2018, which may be affected by non-response, and differential responses in the marginalised populations. Third, these data do not distinguish the duration or severity of the chronic diseases examined. Lastly, although there were strong associations between social vulnerability and disease occurrence, it is not possible to exclude some residual confounding by other social or demographic factors (including age). Also, given the ecological fallacy, the findings should not be interpreted at an individual level.

This study highlights the importance of policy interventions to tackle the pandemic that more explicitly focus on health equity and social justice. A greater attention to, and proportionate resource mobilisation for, disadvantaged counties is needed (including improved opportunities for COVID-19 testing and policies to support appropriate physical distancing), to ensure this pandemic does not widen existing social inequalities.

What is already known on this subject
- In the past, pandemics have disproportionately affected poorer populations, widening existing social inequalities. Given the effect of chronic diseases on risk of severe COVID-19 infection, the present pandemic may have a particularly profound impact on socially disadvantaged counties. As the COVID-19 pandemic has now spread throughout the USA, there is growing evidence of disparities between different socio-economic groups in incidence of, and mortality from, COVID-19. Yet the extent of these disparities, and how they might be addressed, requires further characterisation.

What this study adds
- This national study of 3141 US counties used the Social Vulnerability Index (a widely-used measure of social disadvantage) to stratify counties, and found that as of 10 August 2020, the most socially disadvantaged counties had, on average, twice the rate of COVID-19 cases and deaths relative to the least disadvantaged counties. Similarly, the prevalence of major chronic conditions was also substantially higher in the most disadvantaged counties. Some counties are experiencing a confluence of epidemics from COVID-19 and chronic disease in the context of social disadvantage, which may exacerbate each other and further widen

social inequalities. There was evidence of particular geographic clustering of such counties in the southern USA.

Ethics statements
Patient consent for publication
Not required.

Ethics approval
Since all the data were anonymous, aggregated without any personal information, and publicly available, ethics approval was deemed waived.

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